DS 38: 2D Materials and their Heterostructures III (joint session DS/HL)

Time: Thursday 11:00–12:30 Location: CHE 89

DS 38.1 Thu 11:00 CHE 89

Controllable growth of few-layer graphene — •Victor Aristov[1,2], Alexander Chaika[2,3], Olga Molodtsova[1,4], Sergey Babenkov[1,5], Dmitrii Potorochin[1,4,6], Andrea Locatelli[7], Tevfik Mentes[7], Alessandro Sala[7], and Dmitry Marchenko[8] — [1]Deutsches Elektronen-Synchrotron DESY, 22607 Hamburg, Germany — [2]Institute of Solid State Physics of the Russian Academy of Sciences, Chernogolovka, Moscow District 142432, Russian Federation — [3]CRANN, School of Physics, Trinity College Dublin, Dublin 2, Ireland — [4]ITMO University, 197101 Saint Petersburg, Russian Federation — [5]Institut fuer Physik, Johannes Gutenberg-Universita*t, D-55099 Mainz, Germany — [6]Institute of Experimental Physics, TU Bergakademie Freiberg, D-09599 Freiberg, Germany — [7]Elettra Sincrotrone Trieste, I-34149 Basovizza, Trieste, Italy — [8]Helmholtz-Zentrum Berlin fuer Materialien und Energie, D-12489 Berlin, Germany

Utilizing vicinal SiC/Si(001) wafers one can synthesize self-aligned graphene nanoribbons that exhibit energy transport gap on the order of 1 eV, large positive in-plane magnetoresistance, and the potential to work as a spin filter, opening opportunities for electronic and spintronic applications. This work demonstrates the capabilities to control the lattice and boundary orientations and the layer thickness in-situ, during the few-layer graphene synthesis in an ultra-high vacuum [1]. Supported by the RFBR (Grant Nos. 17-02-01139, 17-02-01291). [1] V.Yu.Aristov et al., ACS Nano 13, 526 (2019)

DS 38.2 Thu 11:15 CHE 89

Proximity-induced spin Hall effect in graphene/WSe_2 van der Waals heterostructures with tunable, highly efficient spin-to-charge conversion — •Franz Herling[1,2], C.K. Safeer[1], Josep Ingla-Aynés[1], Nerea Ontoso[1], Luis E. Hueso[1,3], and Fèlix Casanova[1,3] — [1]CIC nanoGUNE, 20018 Donostia-San Sebastian, Basque Country, Spain — [2]QuESTech, Horizon 2020 ITN, Marie Sklodowska-Curie Action (No 766025) — [3]IKERBASQUE, Basque Foundation for Science, 48013 Bilbao, Basque Country, Spain

The proximity effect in two-dimensional materials opens ways to achieve important functions for future spintronic devices. In van der Waals heterostructures, transition metal dichalcogenides (TMD) can be used to enhance the spin-orbit coupling of graphene leading to highly efficient spin-to-charge conversion (SCC) by spin Hall effect (SHE) that is predicted to be controllable by a gate voltage. Here, we report for the first time the observation of the SHE in graphene proximitized with WSe_2. By Hanle precession measurements, we quantify the spin transport and SCC parameters from 10 K up to room temperature. Exceptional for graphene/TMD devices, the sole mechanism is the SHE for all measurements and no Rashba-Edelstein effect is observable. Importantly, we are able to amplify and turn off the SCC by applying a back-gate voltage, demonstrating the long-awaited milestone of an electrically-tunable SHE. The amplified SCC shows a high efficiency, measured with an unprecedented SCC length of up to 41 nm (with a lower limit of 20 nm).

DS 38.3 Thu 11:30 CHE 89

Thermal conductivity and thermal diffusivity of suspended few-layer h-BN using modified 3ω method — •Sofia Blanter[1], Nicola Paradiso[1], Denis Kochan[2], Kenji Watanabe[3], Takashi Taniguchi[3], and Christoph Strunk[1] — [1]Institute of Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany — [2]Institute for Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany — [3]National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan

We present measurements of thermal conductivity and thermal diffusivity for few-layer suspended hexagonal boron nitride between 25 and 300 K. The measurements are performed on 5-13 nm thick and suspended over a length of 2-10 μm h-BN flakes using a modified version of the 3 omega method.

We generate a temperature gradient by an AC current through a metal heater. Then we measure the temperature difference and the phase shift of the AC temperature response between the heater and a thermometer a small distance away. This allows us to assess the thermal diffusivity of the flake separately from that of the substrate.

Varying the distance between the heater and thermometer, we observe that the phase shift becomes temperature independent for short distances.

DS 38.4 Thu 11:45 CHE 89

Dimensional crossover due to broken symmetry and enhanced thermoelectric performance in graphene antidot lattices — •Mustafa Neşet Çinar and Hâldun Sevinçli — Deparment of Materials Science and Engineering, Izmir Institute of Technology, 35430 Urla Izmir Turkey

Graphene antidot lattices (GALs) are monolayers with periodically placed holes in otherwise pristine graphene. We investigate the electronic properties of symmetric and symmetric GAL structures having hexagonal holes, and show that anisotropic GALs can display a dimensional crossover such that quasi-one-dimensional (Q1D) electronic structures can be realized in two-dimensional systems around the charge neutrality point. We investigate the transport and thermoelectric properties of these Q1D GALs by using non-equilibrium Green function (NEGF) method. Dimensional crossover manifests itself as transmission plateaus, a characteristic feature of Q1D systems, and enhancement of thermoelectric efficiency, where thermoelectric figure of merit, zT, can be as high as 0.9 at room temperature. We further study the transport properties in the presence of Anderson disorder and and that mean-free-paths of Q1D electrons of anisotropic configuration are much longer than those of isotropic one at the same energies.

DS 38.5 Thu 12:00 CHE 89

Electronic structure of thin topological insulator films — •Thomas Naimer, Klaus Zollner, and Jaroslav Fabian — Universität Regensburg, Deutschland

We investigate the electronic structure of thin slabs of the 3D topological insulators Bi2Se3 and Bi2Te3 by means of density functional theory. We present an extensive study of the effects of perpendicular electric fields on the topological surface states. Additionally we examine exchange proximity effects in Cr2Ge2Te6-Bi2Te3 heterostructures. We acknowledge the support of the EU Graphene Flagship program.

DS 38.6 Thu 12:15 CHE 89

Interacting two-electron states in electrostatically confined bilayer graphene quantum dots — •Angelika Knothe and Vladimir Fal'ko — National Graphene Institute, University of Manchester, Manchester M13 9PL, United Kingdom

Successfully utilizing the properties of two-dimensional materials in quantum nanostructure devices could lead to unprecedented electronics applications. We study the possible states of two interacting electrons in a quantum dot electrostatically confined in gapped bilayer graphene. The properties of the material's electronic structure, such as the three minivalleys around each valley, and the corresponding orbital magnetic moment, translate into the features of the dot states. In the weakly gapped case, the single-particle level scheme is that of an almost quadratic band, featuring a singly-degenerate ground state and angular momentum duplet degeneracies. For a sufficiently strong gap, threefold degenerate "minivalley triplets" emerge. For two electrons in the dot, the long-range part of the screened Coulomb interaction defines the orbital configuration of the interacting two-particle state. Short-range contributions breaking the symmetries on the lattice scale determine the ordering in spin and valley space. We identify the set of orbital, spin, and valley levels of the interacting two-particle states.